Testing HDCP 2.3 Compliance of DisplayPort[™] Sinks, Sources and Repeaters

What is HDCP?

High-bandwidth Digital Content Protection (HDCP) is a form of digital copy protection developed by Intel Corporation to prevent copying of digital, audio & video content as it travels across connections (Wikipedia)

((HDCP))



HDCP Uses Three Systems:

- Authentication prevents non-licensed devices from receiving content.
- Encryption of the data sent over the interface prevents eavesdropping of information and man-in-the-middle attacks.
- Key revocation prevents devices that have been compromised and cloned from receiving data.

Content 6 **Multimedia** Source Interface DisplayPort **Multimedia** Sink

(Wikipedia)

Multiple HDCP Versions

- HDCP 1.0 (2000)
- HDCP 1.1... 1.4 (2009)
- HDCP 2.0 (2008) Interface Independent
- HDCP 2.1 (2011)
- HDCP 2.2 (2013) for DP, HDMI, HDBaseT, MHL, USB etc. Not backwards compatible to 2.0, 2.1 & 1.X
- HDCP 2.3 (2018)

((HDCP)) ((HDCP)) ((HDCP))

How to Verify Compliance?

 Digital Content Protection (DCP) LLC establishes

✓ HDCP Standards

- ✓ HDCP Compliance Test Specification (CTS)
- To demonstrate compliance
 - ✓ You have to be a HDCP Licensee
 - ✓ Use a Reference Device
 - ✓ Apply Test Cases defined in the CTS

DIGITAL CONTENT PROTECTION

DIGITAL CONTENT PROTECTION

Reference Device

- Reference Device consists of:
 - Test Equipment hardware (Sink, Source or Repeater)
 - Software to implement the CTS Test Cases

DP HDCP 2.3 CTS Test Cases on UCD Console GUI

<i>///</i> UC	D-323 [1703C168] - DisplayPort Reference Sink (SST, HD	CP 2.2)					
<u>F</u> ile	<u>V</u> iew <u>T</u> ools <u>H</u> elp						
	/Video $Audio Link EDID DPCD HDCP Source DUT Tes$	ting					
8	▷ · Electrical Test Set	Test timeout, milliseconds	200000				
Jevi	▷·CRC based Video Test Set	Revoke ID	30.BB.E2.6E.62				
빙	▷ · Link Test Set						
2	HDCP 2.2 CTS 1A Test Set						
ä	HDCP2.2 CTS 1A-01						
	HDCP2.2 CTS 1A-02						
	HDCP2.2 CTS 1A-03						
	HDCP2.2 CTS 1A-04						
	HDCP2.2 CTS 1A-05						
	HDCP2.2 CTS 1A-06						
		Load Save More Capture	Reset				
	Run Test runs 1 A Time between tests, sec 1 A Clear						
	0004.701.819: DUT enables HDCP encryption						
0004.702.035: STEP 1A-01-7							
	0004.702.092: It checks the correctnes	integrity check complete	IISC 40VD-ID CIAN.				
	0004.722.941: Test PASSED: "HDCP.2 CTS 1A-01"						
	Completed						
	Test data: 0 bytes						
++++ Remaining test runs: 1 ++++							
	0000.000.599: STEP 12-01-1	c100]	-				
	0001.001.572: TE transmits Receiver Co	nnected Indication (Hot plug, CONNECTION STATUS	NOTIFY and IRO HP				
	0001.001.748: [Authentication and Key Exc	hange]	- ~-				
	0001.001.815: STEP 1A-01-2						
	0001.096.477: DUT initiates authentica	tion by transmitting AKE_Init					
	0001.096.562: WARNING. DUT begins the	Authentication and Key Exchange without sending	g unencrypted vide				
	•	m	•				

DCP Approved HDCP 2.3 Compliance Test Tools

 DCP LLC analyzes the test implementation and approves the Authorized Test Devices

	UCD-424	UCD-400	UCD-340	UCD-323	UCD-301
HDCP 2.3 CTS for Transmitter DUT	\checkmark^{\star}	\checkmark	\checkmark	\checkmark	\checkmark
HDCP 2.3 CTS for Receiver DUT	√*	\checkmark	\checkmark	\checkmark	
HDCP 2.3 CTS for Repeater DUT	√*	\checkmark			

*Tests supported but not officiall approved by DCP

Interpreting Results

- CTS Tool SW
 - Provides the user a descriptive log of test actions
 - ✓ Provides user Pass / Fail information
 - **AUX Channel Monitor**
 - ✓ Logs transactions between TE and DUT

00.002: Start test	"HDCP2.	2 CTS 17	A-01"					
00.239: [Before Sta	rting A							
00.301: STEP 1A-01-	STEP 1A-01-1							
00.648: TE trans	TE transmits Receiver Connected Indication/F							
00.817: [Authentica								
00 884: STEP 12-01-	E	Turns	Detaile	Data	Manager datates			
OF FEI. DUT init	From	туре	Details	Data	Message details:			
95.551: DOI INIC	SINK	Native	AUX_ACK - 0 bytes Reg WR 1 bytes to 0x00100	80.01.00.00	Line #77 - 7799.84ms			
95.636: WARNING.	Sink	Native	AUX ACK - 0 bytes	00	AUX_ACK - 2 bytes			
95.812: STEP 1A-01-	Source	Native	Reg WR 1 bytes to 0x00101	80 01 01 00	ADJUST REQUEST LA			
77.646: TE makes	Sink	Native	AUX_ACK - 0 bytes	00	0x00206 := 0x11			
77.719: WARNING.	Source	Native	Req WR 1 bytes to 0x00107	80 01 07 00	VOLTAGE_SWING LA			
77.876: DUT send	Sink	Native	AUX_ACK - 0 bytes	00	PRE-EMPHASIS_LANE			
02.204: TE compu	Sink	Native	ALIX ACK - 0 bytes	00 01 02 0 ⁴	VOLTAGE_SWING_LA			
04 850: TE compt	Source	Native	Reg WR 4 bytes to 0x00103	80 01 03 01	PRE-EMPHASIS_LAN			
of oco. It lies of	Sink	Native	AUX ACK - 0 bytes	00				
US.UGU: [LOCAIITY C	Source		Reg RD 2 bytes from 0x00202	90.02.02.0	ADJUST REQUEST LA			
05.173: STEP 1A-01-	Sink	Native	AUX_ACK - 2 bytes	00.00.00	0x00207 := 0x11			
05.351: DUT send	Source	Native	Req RD 2 bytes from 0x00206	90 02 06 0:	VOLTAGE_SWING_LA			
12.728: TE compu	Sink	Native	AUX_ACK - 2 bytes	00 11 11	PRE-EMPHASIS_LAN			
12.935: [Session Ke	Sink	Native	ALIX ACK - 0 bytes	00	VOLTAGE_SWING_LA			
12 998 STEP 12-01-	Source	Native	Ben BD 2 hytes from 0x00202	90.02.02.0	PRE-EMPHASIS_LAN			
12.413. DUT cond	Sink			00 11 11				
13.415. DUI Sello	Source	Native	Req RD 2 bytes from 0x00206	90 02 06 0:				
13.658: DUI Writ	Sink	Native	AUX_ACK - 2 bytes	00 11 11				
13.857: STEP 1A-01-	Source	Native	Req WR 5 bytes to 0x00102	80 01 02 04				
37.890: DUT enak	SINK	Native	AUX_ACK - 0 bytes	00				
38.105: STEP 1A-01-	Sink			00 77 77				
38.162: TE check	Source	Native	Reg RD 2 bytes from 0x00206	90 02 06 0:				
58.709: Authenti	Sink	Native	AUX_ACK - 2 bytes	00 11 11				
50 072: Test DASSET	Source	Native	Req RD 1 bytes from 0x00204	90 02 04 00				
35.073. 1880 FASSEL	Sink	Native	AUX_ACK - 1 bytes	00 83				
====== Comp	Source	Native	Req WR 1 bytes to 0x00102	80 01 02 00				
ata: A hutae	Source	Native	Reg RD 1 bytes from 0x00200	90.02.00.00				
	Sink	Native	AUX ACK - 1 bytes	00 01				
	Source	Native	Reg RD 3 bytes from 0x00202	90 02 02 0				
	Sink			00 77 77 8: 🗏				
	Source			90 02 02 01				
	Sink	Native	AUX_ACK - 3 bytes	00 77 77 8				
	Source	Native	Reg RD 2 bytes from 0x00206	90 02 06 0:				
	SINK	Nauve	AUX_AUX - 2 Dytes	00 11 11				

Running HDCP 2.3 Compliance Test on DP Source and Sink DUT

Steps to Demonstrate HDCP 2.3 Compliance and Debug Using Unigraf Test Equipment

Source DUT

Test Setup





when needed

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Sour	ce DUT	UCD-323 [1703C168] - DisplayPort x ice Sink (SST, HDCP 2.2) File View Tools Help /Video (Audio (Link (EDID (DPCD)) HDCP (Source DLT Testing))	
status	Reference Sink Verify that "HDCP Capable" box is	HDCP 1.3 Status Active Authenticated Declared as HDCP capable Keys loaded Facsimile - "Test" None	
HDCPS	checked Note HDCP status Verify that HDCP keys have been loaded	HDCP 2.2 Status Authenticated Dedared as HDCP capable Keys Production None	
	UCD Console GUI		

t









Test

Completed Test

	<i>]]]</i> U	CD-323 [1703C168] - DisplayPort Reference Source (s. HDCP 2.2)			
	<u>F</u> ile	View Tools Help			
	DP TX Device	Image: HDCP 2.2 Test Set 100000 Image: HDCP 2.2 CTS 2C Test Set 100000 Image: HDCP2.2 CTS 2C-01 100000 Image: HDCP2.2 CTS 2C-02 100000 Image: HDCP2.2 CTS 2C-03 100000 Image: HDCP2.2 CTS 2C-04 100000 Image: HDCP2.2 CTS 2C-05 100000 Image: HDCP2.2 CTS 2C-06 100000 Image: HDCP2.2 CTS Test Set 100000			
		Load Save More Capture Reset Run Test runs 1 Time between tests, sec 1 Report Clear			
Test result		0002.392.675: Reciever: rates CP_IRQ and makes AKE_Send_H_prime message available 002.431.260: H' is equal to H 002.631.491: Sink DUT does not transmit AKE_Send_Pairing_Info 002.631.697: [Locality Check] 002.631.655: SIEP 2C-01-8 0022.631.958: SourceTE transmits LC_Init message 002.631.958: SourceTE transmits LC_Init message 002.640.129: LC_Send_L_prime message available within 7ms 002.640.256: L Prime matches L 002.640.347: [Session Key Exchange] 002.640.409: SIEP 2C-01-09 002.640.409: SIEP 2C-01-09 002.641.464: Source TE transmits SKE_Send_Eks and Type message 0003.641.464: Source TE transmits visible test pattern to DUT 0003.641.87 Sink DUT completes the authentication process and test pattern is viewed successfully 0003.642.021: Test PASSED: "HDCP2.2 CTS 2C-01" 			
UCD Console GUI					



Analyze AUX





CAPTURING THE WORLD

Summary

- HDCP 2.3 Compliance is verified with Authorized Test Device
- Authorized equipment for testing DP Sink and Source DUT
 - ✓ Unigraf UCD-400, UCD-340, UCD-323 & UCD-301 Test Equipment
 - ✓ UCD Console User Interface (included with UCD-series Test Tools)
 - ✓ DP HDCP 2.3 CTS test cases (license enabled part of UCD Console)
 - ✓ DPA-400 AUX Channel Monitor (for debugging)
- Reports achieved
 - Detailed description of test steps with reference to standard
 - Clear Pass / Fail criteria
 - ✓ Full listing of AUX traffic between Test Equipment and DUT (AUX Monitor)

- Authorized equipment for HDCP 2.3 CTS for DP Sinks, Sources and Repeaters
- 8K@60Hz (with DSC) and 4K@120Hz compliant
- For compliance testing and R&D debugging
- Supports Test Automation





- The only DCP approved HDCP 2.3 CTS test tool for testing USB-C DP Alt Mode Sinks and Sources
- 4K@60Hz compliant
- For compliance testing and R&D debugging
- Supports Test Automation



- Authorized equipment for HDCP 2.2 CTS for DP Sinks and Sources
- 4K@60Hz compliant
- For compliance testing and R&D debugging
- Supports Test Automation



- Authorized equipment for HDCP 2.2 CTS for DP Sources
- 4K@60Hz compliant
- For compliance testing and R&D debugging
- Supports Test Automation



UCD Console for R&D

- Display interface debugging tool
 - Preview video and audio
 - ✓ View status, set interface related parameters
 - Capture and source video, audio and metadata
- Execute bench-top tests
 - ✓ Predefined functionality Test Cases
 - ✓ Standards based Compliance Tests



AUX Channel Monitor DPA-400





Thank You!

Please visit www.unigraf.fi for more information.